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First and Second Station Reports on Task Order N6onr-22528, NR 034-404  
For the periods June 16-September 15, 1951, and September 16-December 15, 1951  
The Ohio State University Research Foundation  
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## PROTECTION OF MOLYBDENUM AGAINST CORROSION AT HIGH TEMPERATURES

### 1. EXPERIMENTAL RESEARCH IN PROGRESS:

- a. Stability of the Binary Alloys Mo-Si, Mo-Ni and Mo-Al Against Oxidation.

Graded ingots of Mo-Si, Mo-Ni and Mo-Al have been obtained from Robert M. Parke of Battelle Memorial Institute. The stability of these alloys in oxidizing atmospheres are being investigated. The character and structure of the oxide formed on these alloys are being studied with the object of ascertaining the prerequisite physical and chemical characteristics of protective oxide films. The graded ingots are ground flat and then polished. The sample is oxidized and the surface of the alloy is examined metallographically, by x-ray analysis and chemically.

- b. The Replacement Reaction in the Oxidation of Binary Alloys of Molybdenum.

In line with the philosophy that the engineering solution to protection of molybdenum against oxidation must come from within, that is by alloying, rather than by external coatings, work has been undertaken to explore the feasibility of the "replacement reaction" in developing protective oxide scales on molybdenum. The principal requirement for the replacement reaction is a solute whose heat of formation of the oxide is considerably higher than that for the solvent. Wagner\* gives an example of the replacement reaction in the oxidation of brass. After one hour at temperature in air, an oxide of copper was formed. After 3 hours at the same temperature in an inert atmosphere, the oxide was entirely converted to zinc oxide since zinc oxide is more stable than copper oxide. This, then, is a method of forming an oxide of the solute when the concentration of the solute is relatively low. This is attractive in molybdenum because any decrease in rate of oxidation comes about only at high concentrations of the solute atom. Although this method is probably not entirely self generating, it may be considered to be semi-self generating. It has the additional advantage of developing oxides of the solute at low concentrations at which they may be useful in the enhancement of mechanical properties.

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\*C. Wagner - High Temperature Oxidation of Metals, Society for Metals, Cleveland, Ohio, 1951.

JAN 23 1952

The replacement reaction is to be studied in the systems Mo-Cr, Mo-Zr, Mo-Ti, Mo-Al, and Mo-Si. All of these solute atoms have significantly higher heat of formation than does molybdenum oxide. The first alloy being studied is a Mo-1% Cr alloy. The procedure is to form molybdenum oxide, heat in an inert atmosphere until the oxide is converted to chromium oxide, and finally to make oxidation tests in air on these samples.

c. The effect of the Interstitial Solution of Carbon, Nitrogen and Oxygen on the Physical Properties of Molybdenum.

The effect of the solid solution of carbon, nitrogen and oxygen on the lattice parameters of molybdenum are being investigated in collaboration with staff members of Battelle Memorial Institute. The study of the effect of carbon has been completed and a Technical Report and a paper to be published in the Journal of Metals in February, has been completed.

At the present time, the effect of nitrogen on the lattice parameter of molybdenum is being studied. Preliminary x-ray measurements show some promise of yielding tangible results.

## 2. THEORETICAL RESEARCH, PAPERS, AND TECHNICAL REPORTS

a. A monograph to be published by the Engineering Experiment Station of The Ohio State University, is in preparation and will be completed in the near future. The title and authors are, "The Theoretical Prediction of the Phase Diagrams of Binary Alloys", by Rudolph Speiser, J.W. Spretnak and W.J. Taylor.

b. "Interstitial Solid Solution in Body-centered Cubic, Face-centered Cubic and Hexagonal Metals", by Rudolph Speiser, J.W. Spretnak and W.J. Taylor. This paper is to be submitted to the A.I.M.E.

c. Technical Report No. 1, dated November 1951, "The Oxidation Characteristics of Molybdenum at High Temperatures", has already been submitted for distribution.

A paper entitled "The Oxidation Characteristics of Molybdenum at High Temperatures", by E.S. Jones, J.W. Spretnak and Rudolph Speiser, is being prepared for publication in the A.S.M.

d. Technical Report No. 2, January 1952, "The Effect of Carbon on the Lattice Parameter of Molybdenum", is now being submitted for distribution.

A paper entitled "The Effect of Carbon on the Lattice Parameter of Molybdenum", by Rudolph Speiser, J.W. Spretnak, W.E. Few and R.M. Parke, is to be published in the February issue of the "Journal of Metals", and is to be presented at the A.I.M.E., Annual Convention in New York City in February.

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